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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 10/020,314      | 12/18/2001  | Yasuhiro Shimamoto   | HITA.0143           | 8410             |

7590 10/21/2003

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EXAMINER

NGUYEN, KHIEM D

ART UNIT PAPER NUMBER

2823

DATE MAILED: 10/21/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

|                              |                               |                                  |  |
|------------------------------|-------------------------------|----------------------------------|--|
| <b>Office Action Summary</b> | Application No.<br>10/020,314 | Applicant(s)<br>SHIMAMOTO ET AL. |  |
|                              | Examiner<br>Khiem D Nguyen    | Art Unit<br>2823                 |  |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

#### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

#### Status

- 1) ☒ Responsive to communication(s) filed on 06 August 2003.
- 2a) ☒ This action is **FINAL**.                      2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

#### Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

#### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 18 December 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.  
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

#### Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☒ All   b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).  
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

#### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

**DETAILED ACTION**

***Response to Amendment***

***Response to Arguments***

Applicant's arguments with respect to claims 1-20 have been considered but are moot in view of the new ground(s) of rejection.

***New Grounds of Rejection***

***Claim Rejections - 35 USC § 102***

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in–

(1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effect under this subsection of a national application published under section 122(b) only if the international application designating the United States was published under Article 21(2)(a) of such treaty in the English language; or

(2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that a patent shall not be deemed filed in the United States for the purposes of this subsection based on the filing of an international application filed under the treaty defined in section 351(a).

Claims 1-3, 11, 13, 14, and 16-20 are rejected under 35 U.S.C. 102(e) as being anticipated by Eguchi et al. (U.S. Patent No. 6 297,122).

In re claims 1, 3, 18, and 19, Eguchi discloses a fabricating method of a semiconductor integrated circuit comprising forming a ruthenium electrode of a capacitor with high-k material on a semiconductor substrate by a chemical vapor deposition method in a sub-atmospheric pressure using an organoruthenium compound as a precursor, which includes (FIGS. 1A-9D and related text):

a first step of providing the semiconductor substrate (FIG. 1B: 101) in a deposition chamber, increasing a temperature of the semiconductor substrate in the chamber up to a desired temperature (col. 5, lines 12-34);

a second step of supplying the precursor into the deposition chamber to form a ruthenium film with a desired thickness on the heated semiconductor substrate (col. 5, lines 37-57) (whereby a diluted precursor of an organoruthenium compound is dissolved in a solvent as the precursor and wherein the ruthenium electrode forming method further includes a step of introducing a balance gas in addition to a carrier gas (Ar) so as to keep a pressure in the deposition chamber constant through all of the other (col. 5, lines 41-47);

a third step of stopping the supply of the precursor and decreasing the temperature of the semiconductor substrate (col. 5, line 66 to col. 6, line 4); and

a fourth step of separately supplying an oxidation gas O<sub>2</sub> into the deposition chamber from the precursor such that the supply of the oxidation gas is separately controlled by the mass-flow controller (FIG. 2, 225) and only during the precursor-supplying step (col. 6, lines 5-16).

In re claim 2, Eguchi discloses wherein the ruthenium electrode is a top electrode and the supply of the oxidation gas into the deposition chamber being carried out through all the first, second, and third steps (col. 6, lines 5-16 and col. 12, lines 32-39).

In re claim 11, Eguchi discloses that the solvent for dissolving the organoruthenium compound comprises tetrahydropuran (col. 5, lines 37-40).

In re claims 13 and 20, Eguchi discloses wherein the annealing temperature in the reducing atmosphere is not more than the annealing temperature for crystallization of the capacitor insulator (col. 5, lines 31-57).

In re claim 14, Eguchi discloses wherein the temperature at which the deformation of crystal grains of the bottom electrode of ruthenium is inhibited is 800 °C or less (col. 5, line 4 to col. 6, line 16).

In re claim 16, Eguchi discloses wherein the electrode of ruthenium of a capacitor with high-k material is formed on the semiconductor substrate, and immediately thereafter annealing is performed at not less than the formation temperature of the bottom electrode of ruthenium in an inert atmosphere or a reducing atmosphere thereby inhibiting deformation of crystal grains of the bottom electrode of ruthenium in the annealing step during or after capacitor insulator formation (annealing at 300° C) (col. 5, line 4 to col. 6, line 16).

In re claim 17, Eguchi discloses wherein the electrode is a bottom electrode (col. 11, line 65 to col. 12, line 39).

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 4-10, 12, and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Eguchi et al. (U.S. Patent No. 6 297,122) as applied to claims 1-3, 11, 13, 14, and 16-20

above, and further in view of Won et al. (U.S. Pub. 2001/0006838) and Yang (U.S. Patent 6,617,248).

In re claims 4-9, Eguchi fails to explicitly disclose that the amount of oxygen adsorption onto the surface of the semiconductor substrate is set to a minimum amount required for de-composing the precursor thereby increasing the amount of oxygen adsorption onto the surface of the semiconductor substrate and shortening a growth time of the electrode. However, the disclose process would obtain the recited results because the same materials are treated in the same manner as in the instant invention.

In re claim 10, Eguchi fails to explicitly disclose the organoruthenium compound comprises bis-(ethylcyclopentadienyl) ruthenium  $[\text{Ru}(\text{C}_2\text{H}_5\text{C}_5\text{H}_4)_2]$ .

Won discloses wherein the organoruthenium compound comprises bis-(ethylcyclopentadienyl) ruthenium  $[\text{Ru}(\text{C}_2\text{H}_5\text{C}_5\text{H}_4)_2]$  (pages 2-3, paragraph [0029]). It would have been obvious to one of ordinary skill in the art at the time of the invention to combine the teaching of Eguchi and Won to enable the organoruthenium compound of Eguchi to be formed and furthermore Ru films having improved continuity and reduced sheet resistance may be obtained (page 2, paragraph [0013]). Additionally, Yang also discloses (col. 2, line 60 to col. 3, line 58) wherein the organoruthenium compound comprises bis-ethylcyclopentadienylruthenium  $[\text{Ru}(\text{C}_2\text{H}_5\text{C}_5\text{H}_4)_2]$ .

In re claim 12, Eguchi fails to explicitly disclose performing annealing at not less than a formation temperature of the bottom electrode of ruthenium in a reducing atmosphere containing hydrogen thereby inhibiting deformation of crystal grains of the

bottom electrode of ruthenium in the annealing step during or after capacitor insulator formation.

Yang discloses performing annealing at not less than a formation temperature of the electrode of ruthenium (at between about 400 to 800° C) in a reducing atmosphere containing hydrogen (col. 2, line 60 to col. 3, line 58) thereby inherently inhibiting deformation of crystal grains of the electrode of ruthenium in the annealing step during or after capacitor insulator formation. It would have been obvious to one of ordinary skill in the art at the time of the invention to combine the teaching of Eguchi and Yang to enable the process of annealing the bottom electrode of ruthenium in a reducing atmosphere containing hydrogen of Eguchi to be performed and furthermore to obtain a ruthenium metal layer having various degrees of smooth and rough textures (Abstract).

In re claim 15, Eguchi fails to explicitly disclose wherein an average grain size of the crystal grains of the bottom electrode of ruthenium is 30 nm to 60 nm. However, there is no evidence indicating that the average grain size of the crystal grains of the bottom electrode of ruthenium is critical and it has been held that it is not inventive to discover the optimum or workable size or thickness of a result-effective variable within given prior art conditions by routine experimentation. See MPEP § 2144.05. Note that the specification contains no disclosure of either the critical nature of the claimed dimensions of any unexpected results arising there from. Where patentability is aid to be based upon particular chosen dimensions or upon another variable recited in a claim, the Applicant must show that the chosen dimensions are critical. In re Woodruff, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

***Response to Amendment***

***Response to Arguments***

Applicant's arguments with respect to claims 1-20 have been considered but are moot in view of the new ground(s) of rejection.

***Conclusion***

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Khiem D Nguyen whose telephone number is (703) 306-0210. The examiner can normally be reached on Monday-Friday (8:00 AM - 5:00 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on (703) 306-2794. The fax phone numbers



Art Unit: 2823

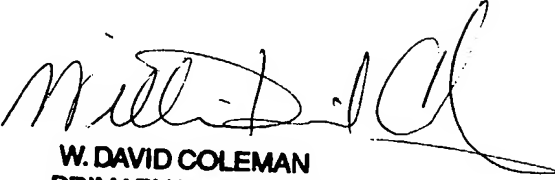
for the organization where this application or proceeding is assigned are (703) 746-9179

for regular communications and (703) 746-9179 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

K.N.

October 12, 2003



**W. DAVID COLEMAN**  
**PRIMARY EXAMINER**